

SECTION 71

SANITARY SEWERS AND STORM SEWERS

NOTE: **THIS SECTION IS ADDED IN ITS ENTIRETY TO THE BLANK SECTION IN THE CALTRANS STANDARD SPECIFICATIONS.**

Unless specifically differentiated herein, references to Sanitary Sewers also references Storm Sewers (aka. Storm Drains).

71-1.01 Description - This work shall consist of laying sewer pipe and constructing sewer structures as shown on the Project Plans, in accordance with these Standard Specifications and Plans, the Special Provisions and as directed by the Engineer.

The type of sewer pipe and sewer structures will be designated in the contract items.

71-1.02 Materials - Pipe, fittings, miscellaneous materials and the most common joint materials are described in this Section 71-1.02.

Portland cement used in the production of concrete products set forth in this Section 71-1.02 shall be Type II Modified cement conforming to the provisions in Section 90, "Portland Cement Concrete."

71-1.02A Reinforced Concrete Pipe (RCP) - Reinforced concrete pipe shall conform to A.S.T.M. Designation C-76 for the size and classes indicated on the Project Plans. For sanitary sewer applications, RCP shall be used only on sewer lines 36-inch and larger.

71-1.02A(1) Plastic Lining – All RCP used in sanitary sewer applications shall be lined with plastic lining. The full three hundred and sixty degrees (360°) of the interior circumference of all reinforced concrete pipe to be used in Sanitary Sewer Systems shall be sealed and protected with a polyvinyl chloride resin lining. Copolymer resins will not be permitted.

The plastic liner shall be impermeable to sewage gases and liquids and shall be nonconductive to bacterial or fungus growth. The lining shall be impact resistant, flexible, and shall have an elongation sufficient to bridge up to 1/8" settling cracks which may take place in the pipe or in the joint after installation without damage to the lining.

The lining shall be of a type that is permanently and physically embedded into the concrete pipe wall by the T-lock mechanism and shall not rely on an adhesive bond between the lining and pipe wall.

The lining at all pipe joints, and at all joints between individual sheets or sections of lines shall be continuously heat welded by the use of welding strips of the same kind and equivalent thickness of the material as the lines.

The contract shall submit for the Engineer's consideration written information as to the type, size, workmanship and other specifications for the plastic liner the Engineer proposes to use on any installation. Approval of this submission by the Engineer shall be obtained prior to any material being delivered to the job site.

71-1.02B Clay Pipe - Vitrified clay pipe shall conform to the specifications for extra strength pipe of A.S.T.M. Designation C-700 and C-301.

71-1.02C Ductile Iron Pipe - Ductile iron pipe shall comply with ANSI A21.51 (AWWA C151).

71-1.02D Acrylonitrile-Butadiene-Styrene (ABS) Pipe (Sewer Pipe) – Pipe sizes four (4) inch and six (6) inch diameter shall conform to ASTM D2751-80 with minimum wall thickness determined by SDR 35.

Pipe sizes eight (8) through fifteen (15) inch diameter shall conform to ASTM D2680-80 with Type OR or Type SC joints.

71-1.02E Polyvinyl Chloride (PVC) Pipe - All solid wall pipe and fitting in 4” through 15” diameters shall be type PSM SDR-35 PVC, ASTM 3034; 18" through 24" shall be type PS 46 PVC, ASTM F679. Pipe and fittings shall be marked as per ASTM requirements.

Profile wall polyvinyl chloride pipe (PWPVC) may be used for pipe sizes 21-inch through 48-inch.

PWPVC shall be manufactured from a PVC compound having a minimum cell classification of 12364A as defined in ASTM D 1784. Gasket shall meet the requirements of ASTM F 477.

PWPVC shall be closed profile, ASTM F 1803-97 for 21” – 48” diameters with a bell and spigot gasketed joint. The joint shall meet the requirements of ASTM D 3212. The pipe shall have a minimum pipe stiffness when tested in accordance with ASTM D 2412.

Tests for compliance with this specification shall be made according to the applicable ASTM Specifications at the time of manufacturing. The manufacturer shall provide a certificate of compliance with this specification. In addition, the CITY may, at his own expense, station a representative or third party inspector at the site of manufacture to continuously monitor the manufacturing process, and to independently test the pipe to verify conformance with the project specification. Pipe tests and frequency shall be determined by the City.

PWPVC Nominal Dimensions:

Nominal Diameter (in.)	Outside Diameter (in.)	Inside Diameter (in.)
21	22.110	20.75
24	25.040	23.50
27	28.232	26.50
30	31.430	29.50
36	37.800	35.50
42	44.200	41.50
48	50.57	47.50

Unless otherwise approved by the CITY, all pipe shall be unloaded in the original packaging using a forklift with fork arms long enough to reach beyond the last pipe bundle. Do not roll the pipe off of the truck. Pipe shall not be handled or secured using chains or cables; a nylon or textile strap is recommended.

In addition to the requirements reflected in Section 71-1.05 Pipe Laying, the pipe bedding shall be carefully placed and compacted in the haunching. The haunching area extends from the bottom of the pipe to the springline of the pipe. Bedding shall be placed in 6" loose lifts on alternate sides of the pipe. A Tamping bar or shovel shall be used to facilitate bedding consolidation on the lower quadrant of the pipe. The bedding shall be mechanically compacted using hand operated equipment in accordance with the manufacturer's recommendations. The bedding material and its proper placement are the most important factors affecting the performance (side support) of the pipe.

Initial Backfill shall be placed to protect the pipe from dropping of large rocks, large mechanical compaction equipment or other impact loads that may occur during final backfill.

Pipe Deflection Testing: Pipe testing shall be performed in accordance with Section 71-1.11B.

71-1.02F Miscellaneous Iron and Steel - Miscellaneous iron and steel items shall conform to the provisions in Section 75, "Miscellaneous Metal."

71-1.02G Reinforcement - Reinforcement shall conform to the provisions in Section 52, "Reinforcement."

71-1.02H Concrete - Concrete shall conform to the provisions in Section 51, "Concrete Structures," and Section 90, "Portland Cement Concrete."

71-1.02I High Density Polyethylene Pipe (HDPE) - HDPE pipe and fittings shall be made of high density, high molecular weight, Type III, Class C, Category 5, Grade P34 polyethylene meeting the requirements of ASTM D1248 and ASTM F894 unless specified otherwise

herein. Wall configurations and thicknesses shall meet the deflection requirements of this section. Crushing and buckling strengths shall exceed that required from the loads anticipated. Pipe selection and deflection design shall also be based upon a pipe stiffness not less than 20 psi and a modulus of soil reaction no greater than 1400. Pipe stiffness shall be tested prior to installation in accordance with ASTM D2412 with a 5% deflection at a rate of 1/2 inches per minute.

71-1.03 Excavation and Backfill - Excavation and backfill shall conform to the provisions shown on City of Stockton Standard Plans No. 50 and 51.

The pipe shall be laid in a trench excavated to the lines and grades designated by the Engineer. The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe barrel.

Suitable excavation shall be made to receive the bell of the pipe and the joint shall not bear upon the bottom of the trench. All adjustment to line and grade shall be made by scraping away or filling in with sand, gravel, or granular material under the body of the pipe, and not by wedging or blocking.

Trenches shall not be left open farther than 100 feet in advance of pipe laying operations or 100 feet to the rear thereof.

The excavation shall be supported so that it will be safe and that the ground alongside the excavation will not slide or settle and all existing improvements, either on public or private property, will be fully protected from damage.

All supports shall be removed after construction is completed and shall be withdrawn in a manner that will prevent the caving of the sides of the excavation. All openings caused by the removal of supports shall be filled with suitable material properly compacted.

71-1.04 Bedding - Bedding shall be defined as that material supporting, surrounding and extending to one foot above the top of the pipe. Where it becomes necessary to remove boulders or other interfering objects at subgrade for bedding, any void below such subgrade shall be filled with the bedding material designated on the Project Plans. Where concrete is specified to cover the pipe, the top of the concrete shall be considered as the top of the bedding.

If soft, spongy, unstable, or other similar material is encountered upon which the bedding material or pipe is to be placed, this unsuitable material shall be removed to the depth specified by the Engineer and replaced with bedding material suitably densified.

Bedding material shall first be placed so that the pipe is supported for the full length of the barrel with full bearing on the bottom segment of the pipe equal to a minimum of 0.5 times the outside diameter of the barrel. Densification of bedding for pipe shall be accomplished after the sheeting or shoring has been removed from the bedding zone. Alternate methods of pipe laying which are recommended by the pipe manufacturer may be used if reviewed

by the Engineer. The bedding zone for PVC, ABS, and HDPE pipe shall be mechanically compacted before the remainder of trench is compacted.

Bedding material shall be sand, gravel, crushed aggregate, native free-draining granular material having a sand equivalent of not less than 20 as specified on Standard Plans Nos. 50 and 51 for trench backfilling.

Pea gravel is not acceptable. No aggregate shall exceed 1".

In cases where native material is suitable for use as bedding, the trench may be excavated to point above the invert grade and the trench bottom hand-shaped so that the bottom segment of the pipe is firmly supported on undisturbed material.

Bedding material for HDPE pipe shall be 3/4" crushed rock. The portion of the material that is larger than will pass a 3/8" sieve shall contain at least 50% of particles having three or more fractured faces. Not over 5% shall be pieces that show no such faces resulting from crushing. The gradation of the crushed rock shall be as follows:

<u>Sieve Size</u>	<u>3/4"</u>
1 1/2"	-
1 "	100
3/4 "	90-100
1/2 "	30-60
3/8"	0-20
No. 4	0-5
No. 8	-

This material shall be compacted to the density and level shown on Drawing 51-A.

71-1.05 Pipe Laying - Pipe shall be protected during handling against impact shocks and free fall. Pipe will be carefully inspected in the field before and after laying. If any cause for rejection is discovered in a pipe after it has been laid, it shall be subject to rejection. Any corrective work shall be reviewed by the Engineer and shall be at no cost to the City.

When connections are to be made to any existing pipe, conduit, or other appurtenances, the actual elevation or position of which cannot be determined without excavation, the Contractor shall excavate for, and expose, the existing pipe improvement before laying any pipe or conduit. The Engineer shall be given the opportunity to inspect the existing pipe or conduit before connection is made. When the new facilities interfere with the existing flow of sewage, the Contractor shall provide satisfactory bypass facilities at the Contractor's expense.

The pipe shall be laid without break upgrade from structure to structure, with bell end upgrade, unless otherwise permitted by the Engineer.

All joints shall be cleaned and then sealed with the type of materials specified or required by the City. In the absence of such requirements the pipe shall be jointed with materials recommended by the pipe manufacturer for the purpose intended, and reviewed by the Engineer, in order to obtain a watertight joint against leakage and infiltration under all conditions of expansion, contraction, and settlement.

Whenever the work ceases for any reason, the end of the pipe shall be securely closed with a tight fitting plug or cover.

Whenever existing pipes are to be cut or abandoned, the open ends of said pipes shall be securely closed by a tight fitting plug or wall of concrete not less than 0.5 foot thick, or by a tight brick wall 0.67 foot thick with cement mortar joints.

Where ground water occurs, the bottom of the trench shall be kept entirely free of water during the pipe laying, filling the joints, and as long thereafter as directed by the Engineer.

All joints shall be carefully cleaned on the inside.

Stoppers for pipes and branches left unconnected shall be made of the same material as the pipe or of resilient joint material conforming to Section 71-1.02J, "Resilient Joint Material."

After placing the stopper, it shall be covered with a layer of sealant. The sealant shall be sufficiently fluid to insure free flow around the stopper.

Concrete pipe with elliptical reinforcement shall be laid with the minor axis of the reinforcement cage in a vertical position.

Pipe shall be laid true to line and grade. Any pipe, which is not in true alignment or shows any undue settlement after laying shall be taken up and re-laid at the Contractor's expense.

Pipe sections shall be laid and joined in such a manner that the offset of the inside of the pipe at any joint will be held to a minimum at the invert. The maximum offset at the invert of pipe shall be 1 percent of the inside diameter of the pipe or 3/8 inch (9.5 mm), whichever is smaller.

In joining socket and spigot pipe, the spigot of each pipe shall be so seated in the socket of the adjacent pipe as to give a minimum of 3/8 inch (9.5 mm) annular space all around the pipe in the socket. Unavoidable offsets shall be distributed around the circumference of the pipe in such a manner that the minimum offset occurs at the invert.

Pipe shall be laid true to line and grade. Any pipe which deviates from the engineering alignment by 1/2" or grade by 1/4" or results in a reverse slope or shows any undue settlement after laying shall be taken up and re-laid.

After the joints have been made, the pipe shall not be disturbed in any manner.

During installation, linear expansion and contraction shall be kept below the manufacturer's recommendations. Strutting shall be mandatory for size 36" and larger. A strutting detail shall be reviewed by the City Engineer prior to installation. Pre-deflecting the pipe shall only be permitted subsequent to approval from the City Engineer.

71-1.06 Pipe Joints

71-1.06A Vitrified Clay Pipe - Either polyvinyl chloride or polyurethane compression joints may be used. Materials shall conform to A.S.T.M. Designation C-425.

Joints shall contain two sealing components, one bonded to the outside of the spigot and the other bonded to the inside of the socket. Sealing components shall be a plasticized polyvinyl chloride compound or polyurethane elastomer bonded to pipes and fittings at the pipe factory, and shall be cured to a uniform hardness and compressibility. The sealing components shall be shaped, sized, bonded, and cured in such a manner as to form a tight, dense, and homogenous compression coupling when the joint is assembled. Any imperfection in the sealing components will be cause for rejection.

Upon installation, the meeting surfaces shall be wiped clean of dirt and foreign matter, then an approved lubricant shall be applied to the joint surfaces. The spigot shall be positioned inside the socket and the joint shoved home. For large diameter pipe, a lever attachment or bar cushioned with a wooden block shall be used to shove the joint into place.

In no case shall a bar be used on an unprotected joint surface. Mating surfaces shall be in tight contact with each other upon completion of the joint installation.

Polyvinyl chloride joints may be used on curves, provided that the radius of curvature is not less than shown in the following table, unless beveled pipe or shorter lengths are provided:

Pipe Size Inches	Maximum Pipe Length Feet	Minimum Radius of Curvature Feet	Maximum Deflection
6	5	100	2° 00'
8	5	100	2° 00'
8	6	115	2° 00'
10	5	185	1° 33'
10	6	220	1° 33'
12	5	215	1° 20'
12	6	260	1° 20'
15	5	275	1° 03'
15	6	330	1° 03'

Polyurethane joints may be permitted for use on curves, provided that the radius of curvature is not less than shown in the following table, unless beveled pipe or shorter lengths are provided.

Pipe Size Inches	Maximum Pipe Length Feet	Minimum Radius of Curvature Feet	Maximum Deflection
6	5	100	2° 00'
8	5	100	2° 00'
8	6	115	2° 00'
10	5	170	1° 41'
10	6	205	1° 41'
12	5	150	1° 54'
12	6	180	1° 54'
15	5	190	1° 32'
15	6	225	1° 32'
18	5	225	1° 16'
18	6	275	1° 16'
21	5	265	1° 06'
21	6	315	1° 06'
24	5	240	1° 12'
24	6	290	1° 12'
27	5	270	1° 04'
27	6	325	1° 04'
30	5	300	0° 58'
30	6	360	0° 58'
33	5	275	1° 03'
33	6	330	1° 03'
36	5	295	0° 59'
36	6	355	0° 59'
39	5	325	0° 54'
39	6	385	0° 54'
42	5	345	0° 50'
42	6	415	0° 50'

71-1.06B Reinforced Concrete Pipe. All reinforced concrete sanitary sewer pipe shall be joined with rubber gasket joints.

Rubber gasket joints shall conform to the requirements of A.S.T.M. Designation: C443 and shall be flexible and able to withstand expansion, contraction and settlement.

All rubber gaskets shall be stored in as cool a place as practicable, preferably at 70° or less, and in no case shall the rubber gaskets be exposed to the direct rays of the sun for more than 72 hours.

Rubber gaskets, of the type requiring lubrication, shall be lubricated with the lubricant recommended and supplied by the manufacturer of the pipe.

The ends of the pipe shall be so formed that when the pipes are laid together and joined, they shall make a continuous and uniform line of pipe with a smooth and regular surface.

Joints shall be water-tight and flexible. Each joint shall contain a solid gasket of rubber or other material approved by the Engineer, which shall be the sole element responsible for water-tightness of the joint. This gasket shall be of circular cross section unless otherwise approved by the Engineer. The length and cross sectional diameter of the gasket, the annular space provided for the gasket, and all other joint details shall be such as to produce a water-tight joint. The slope of the longitudinal gasket contact surfaces of the joint with respect to the longitudinal axis of the pipe shall not exceed 2°.

Under ordinary laying conditions, the work shall be scheduled so that the socket end of the pipe faces in the direction of laying. Prior to placing the spigot into the socket of the pipe previously laid, the spigot groove, the gasket and the inside of the socket shall be thoroughly cleaned. Then the spigot groove, the gasket and the first 2 inches (50.8 mm) of the inside surface of the socket shall be lubricated with a soft vegetable soap compound.

The gasket shall be uniformly stretched when placing it on the spigot so that the gasket is distributed evenly around the circumference. The gasket shall be lubricated as per manufacturer's recommendations.

For pipe in which the inside joints are to be pointed, suitable spacers shall be placed against the inside shoulder of the socket to provide the proper space between abutting ends of the pipe.

After the joint is assembled, a thin metal feeler gage shall be inserted between the socket and the spigot and the positions of the gasket checked around the complete circumference of the pipe. If the gasket is not in the proper positions, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position again checked.

71-1.06C Ductile Iron Pipe. Ductile iron pipe joints shall comply with the following requirements:

<u>Type of Joint</u>	<u>Specification</u>
Rubber Gasket Push-On Joint	ANSI A21.11 (AWWA C111)
Mechanical Joint	ANSI A21.11 (AWWA C111)
Flanged Joint	ANSI B16.1, B.16.2, and A21.10
Flanged Joint (Threaded Flanges)	ANSI B2.1

All rubber gasket, push-on, mechanical and flanged joint fittings for ductile iron pipe shall be manufactured in accordance with ANSI A21.10 (AWWA C110).

Slip-On Joint - The gasket and gasket seal inside the socket shall be wiped clean before the gasket is inserted. A thin film of soft vegetable soap compound shall be applied to the gasket and the outside of the spigot end of the pipe. The spigot shall then be positioned inside the socket and shoved home. Lubricant other than that furnished with the pipe shall not be used.

Mechanical Joints - The outside of the spigot and the inside of the socket shall be thoroughly cleaned of foreign matter. The gland and gasket shall then be slipped onto the spigot end of the pipe. The gasket shall be pressed evenly into the socket only after the spigot is seated in the socket. The gland shall be brought up evenly by tightening alternately the nuts spaced 180° apart. Bolts and nuts shall be coated with mastic following tightening.

Flanged Joints - Flanged Joints shall be firmly and fully bolted with machine bolts of proper size. Full circle reinforced neoprene rubber gaskets 1/16" thick shall be used at all flanged joints. Bolts and nuts shall be coated with mastic following tightening.

71-1.06D ABS Sewer Pipe

1. Pipe lengths and fittings shall be joined by utilizing elastomeric gaskets as referenced in A.S.T.M. D-2680 and D-2751 and meeting the requirements of A.S.T.M. D-3212 "Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals," or solvent weld joints.

Solvent weld joint or usage shall conform to A.S.T.M. F-402 "Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings," and the following requirements:

- a. All ABS pipe joints, fittings and surfaces to be joined by solvent welding shall be connected with adhesive cement conforming to A.S.T.M. D2680 for ABS composite sewer pipe or to A.S.T.M. D2751 for 4-inch and 6-inch ABS solid wall pipe.
- b. Prior to joining ABS pipe joints, fittings and surfaces, dirt, mud or any other foreign material shall be thoroughly removed and cleaned from the joints, fittings and surfaces to be joined.
- c. A coat of adhesive cement shall be liberally and thoroughly applied to the joints, fittings and surfaces to be joined. After application of the adhesive cement, the pipe joints, fittings, and surfaces to be joined shall be immediately fitted and joined without interruption.

For bell and spigot connections, the spigot end of each pipe shall be fitted to the full depth of the bell socket.

- d. When the temperature is below 40° F., a primer shall be applied to the pipe surface to be cemented and joined.

2. Reducing Wyes:

- a. Reducing wyes for service laterals shall be either saddle type wyes or in-line bell and spigot type wye fittings. All reducing wyes shall be premoulded and factory fabricated.
- b. Saddle Fittings:
 - 1. In addition to the solvent welding of the saddle to the main pipeline, the saddle type wye shall be attached to the main pipeline with a stainless steel clamp.
 - 2. Tapping hole for saddle fittings shall be cut with a cutting instrument. The hole shall be of the same size and shape of the lateral pipe surface.

3. Exposed Pipe Cross-Sections:

Exposed cross-sections of the ABS composite sewer pipe shall be coated with adhesive cement prior to connection of pipe joints, fittings and surfaces.

4. Maintenance Hole Connections:

Maintenance hole connections shall be by rubber ring water stop installed on pipe and cast in center of maintenance hole wall or four (4) inches from outside face of maintenance hole base. Pipe section on water stop at maintenance hole shall have bell flush with outside of maintenance hole or no more than ten (10) inches outside maintenance hole.

71-1.06E PVC Pipe

1. All joints shall be integral wall bell and spigot configuration, factory formed in accordance with ASTM D3212. All rubber rings shall conform to A.S.T.M. F-477.
2. Reducing wyes for service laterals shall be in line bell and spigot type, factory moulded.
3. Saddle fittings for lateral connection will be permitted; solvent welded.
4. Maintenance hole connections shall be by rubber ring water stop installed on pipe and cast in center of maintenance hole wall or four (4) inches from outside face of maintenance hole base. Pipe section on water stop at maintenance hole shall have bell flush with outside of maintenance hole or no more than ten (10) inches outside maintenance hole.

71-1.06F HDPE Pipe

Joints for HDPE shall be bell and spigot or butt-fusion type. Bell and spigot types shall have an elastomeric gasket which will be compressed radially to form a watertight seal. The joint shall be designed to avoid displacement of the gasket when installed with the manufacturer's recommendations.

71-1.07 Deformation Testing - Following the placement and compaction of backfill and prior to placement of permanent pavement, the Contractors shall perform a deflection test on the pipe. If the pipe should fail the deflection test, the Contractor shall uncover the pipe and make adjustments in the bedding and/or backfill conditions that will be necessary to achieve a passing test. The trench shall be backfilled and street subgrade shall be recompact and the pipe retested. Any corrective measures found necessary to meet the deflection requirements, including recompaction and regrading of the street subgrade, shall be included in the unit price bid for the sanitary sewer pipe.

See Section 71-1.11 for method and extent required.

- a. Maximum deflection for ABS composite sewer pipe installed is 4%.

71-1.08 Existing Maintenance Holes - Existing maintenance holes shall be adjusted to grade, remodeled or abandoned as shown on the Project Plans and in accordance with the provisions in Section 15, "Existing Highway Facilities."

When designated on the Project Plans, or directed by the Engineer, existing maintenance hole frames and covers shall be reset on new structures. Upon completion of the adjustment of existing maintenance holes to grade, the maintenance hole cover shall conform to the planned surface as specified for the finished asphalt concrete surface, Section 39.

All existing maintenance holes, lampholes and terminal cleanout frames and covers that are removed become the property of the City of Stockton.

71-1.09 Sewer Structures - New maintenance holes, lampholes, terminal cleanout structures, and pipe chimneys for sewers shall be constructed in accordance with the details shown on the Standard Plans, as specified in this Section 71-1.09 and as directed by the Engineer.

Precast maintenance hole, pipe maintenance holes shall conform to the Standard Plans, the Project Plans, and the applicable sections in Section 70.

Maintenance hole frames shall be secured to the maintenance hole cover and riser barrels with full mortar bed or full circle concrete collar that will effectively secure the frame to the maintenance hole structure and provide a uniform bearing for the frame.

Concrete for sewer structures shall be Class A as described in Section 90-1.01. Concrete for sewer maintenance bases shall be Class B.

When the maintenance hole is located in the pavement area, it shall not be constructed to final grade until pavement has been completed.

Where new work is jointed to the surface of unfinished work, the latter shall be thoroughly cleaned.

All joints on the inside of structures and sewers shall be neatly struck and pointed where plastering is not specified on the plans.

The inside bottoms of existing maintenance holes, where new connections are made, and of new maintenance holes shall be shaped to provide channels conforming to the size and shape of the lower portion of the inlets and outlets of the maintenance holes. The channels shall vary uniformly in size and shape from inlet to outlet.

No pipe shall project more than 0.17 foot into a maintenance hole and in no case shall the bell of a pipe be built into the wall of a maintenance hole or structure.

All concrete shall be cured for a period of not less than 10 days after being placed and shall be protected from damage.

71-1.09A Maintenance Hole Interior Linings and Coatings

General - The interior of all new maintenance holes along sanitary sewer lines 24" and larger, which will be maintained by the City, shall be either lined or coated. In addition, the interior of any existing City Maintenance hole(s), downstream from a new Sanitary Sewer system, determined by the City Engineer, to be adversely affected by the additional sewage, shall be either lined or coated.

Material - If lined, the material shall be made of polyvinyl chloride and conform to the requirements as set forth in Section 71-1.02A(1).

If coated, the coating shall be resistant to attack from the following: bleaches; sulfuric, acetic, hydrochloric, phosphoric, nitric, chromic, oleic, and stearic acids; sodium and calcium hydroxides; ammonium, sodium, calcium, magnesium, and ferric chlorides; ferric sulfate, hydrogen sulfides, petroleum oils and greases, vegetable and animal oils, fats, greases, soaps and detergents. The coating shall be impermeable to sewage gases and liquids and shall be non-conductive to bacterial or fungus growth.

Acceptable coatings are as follows:

<u>PRODUCT NAME</u>	<u>PRODUCT TYPE</u>	<u>MANUFACTURER</u>
120 Vinester	Vinylester Mortar	Tnemec Company, Inc.
Chesterton 798	Epoxy Mortar	A.W. Chesterton Company
Concresive 1305	Epoxy	Adhesive Engineering Company
Hydro-pox	Epoxy	Con-Tech
I.E.T. System 3	Polyester Mortar	Integrated Environmental Technologies
I.P.I. Crystal Quartz	Epoxy Mortar	Integrated Polymer Industries, Inc.
Lining No. 210	Epoxy	Sauereisen Cements
Maga Quartz	Epoxy Mortar	Belzona Molecular, Inc.
Mainstay DS-4	Epoxy Mortar	Mainstay Corporation
Quantum	Polyester Mortar	Polymorphic Polymer's Corporation
Semstone 140S	Epoxy Mortar	Sentry Polymers

The City Engineer, at the City Engineer's discretion may , at any time, determine that a product is not suitable for specific applications. Additionally, this list may be reviewed annually by the Materials Review Committee and products may be determined not suitable for specific applications.

Surface Preparation - For coatings, it is the intent of this standard that the application surface be clean and dry. Surfaces shall be cleaned to achieve an ASTM D-4259 Standard by abrasive blast cleaning methods. All surfaces shall be cleaned to remove all dirt, dust, corrosion products, loose concrete, debris, grease, oils, growths and foreign matter. On new concrete and metal surfaces, a sandblasting shall be used to remove all laitance. Coatings shall be applied only to a sound clean surface profile consistent with the manufacturer's published recommendation.

New concrete shall be aged no less than 30 days prior to application.

Cracks, joints, eroded and damaged areas shall be sealed with a compatible grout/putty as recommended by the coating manufacturer prior to the application of the coating material.

Application - All coating materials shall be applied in a manner and thickness consistent with the manufacturer's published recommendation.

All coatings shall be applied in a manner consistent with all applicable environmental and health and safety regulations. At a minimum, during application, the applicators shall use protective clothing, eye protection, chemical resistant gloves, and air respirators.

The coating shall be free of blisters, pinholes, holidays, or discontinuities.

Inspection - All coating work shall be performed in the presence of the designated City construction inspector. All coating work done in the absence of the inspector is subject to rejection unless specifically allowed by the inspector. The inspector shall be provided access to the construction site and to those areas subject to the performance of work under this standard.

Testing - All testing shall be performed by the contractor in the presence of a City inspector. All lining and coating work shall be high-voltage spark tested at a minimum 125 volts per mil film thickness of coating. Contractor shall verify to the City that the test equipment is in proper working condition prior to spark testing. Use Tinker-Rasor AP-W test equipment or approved equal.

Repairs of Holidays or Pinholes - All areas to be repaired, as determined by inspection and testing, shall be repaired in accordance with the product manufacturer's recommendations.

71-1.10 Trench Resurfacing - Trenches in existing streets, except streets which are to be closed or abandoned, shall be resurfaced with the type and thickness of bases, surfacing or pavement, as shown in these Standard Specifications and Plans. The Contractor shall proceed immediately to resurface any part of any excavation upon notice from the Engineer without waiting for completion of the full length of the sewer. All trenches shall be backfilled or covered at the end of each working day. Any temporary trench patching shall be approved by the City Engineer.

71-1.11 Testing:

71-1.11A Cleaning - Prior to performing tests, the pipe installation shall be thoroughly cleaned. Cleaning shall be performed by the Contractor by means of an inflatable rubber ball. The ball shall be of a size that will inflate to fit snugly into the pipe to be tested. The ball shall be controlled with a tag line. The ball shall be placed in the last lamphole or maintenance hole on the pipe to be cleaned, and water shall be introduced behind it. The ball shall pass through the pipe with only the pressure of the water impelling it. All debris flushed out ahead of the ball shall be removed at the first maintenance hole where its presence is noted. In the event cement or wedged debris or a damaged pipe shall stop the ball, the Contractor shall remove the obstruction.

71-1.11B Deflection Test for ABS, PVC, (Solid Wall and Profile Wall), and HDPE Sanitary Sewer Pipe – A short-term deflection test shall be conducted no sooner than 30 days after the placement and densification of backfill. The Contractor shall furnish all equipment needed to complete this test. The cost for the deflection test shall be included in the unit price bid for the sanitary sewer pipe.

For PVC pipe, the allowable short-term deflection shall be 5%. The minimum allowable I.D. (O.D. of the mandrel) shall be established by the pipe manufacturer.

For ABS Pipe - All mainline pipe shall be cleaned and then mandrelled to measure for obstructions (deflection, joint offsets, lateral intrusions, etc.). A rigid mandrel with a circular cross-section having a diameter at least 96% of the specified average inside diameter shall be pulled through the pipe. The method of measuring the deflection shall be reviewed by the City Engineer. Any pipe through which the mandrel will not pass shall be said to have failed and will be repaired by the Contractor at the Contractor's expense.

For HDPE pipe--maximum long term deflection for HDPE pipe shall be no more than 5%. Long-term deflection shall be calculated as the short-term deflection multiplied by a deflection lag factor based upon the average inside diameter of the pipe. In no case shall a deflection lag factor of less than 1.5 be accepted. Mandrel deflection tests may be required during installation as specified by the City Engineer. Mandrels used in testing shall have an odd number of legs totaling no less than nine. Pipe sections not meeting the deflection requirements shall be excavated, re-installed, and subject to an additional 30-day deflection test.

At the Engineer's option, the Engineer may require a sample of ten percent (10%) of the laterals randomly selected by the inspectors shall also be tested for deflection. If difficulty is encountered in passing the mandrel test, the inspector may direct that a larger sample of laterals be tested up to and including one-hundred percent (100%) of all laterals.

The Contractor shall furnish properly sized mandrels for size and type of pipe installed. Certification of proper mandrel size shall be required and mandrel identified in a manner to identify with certification.

At the Contractor's expense, all locations with deflection greater than allowable shall be excavated, repaired or replaced, backfilled and retested.

71-1.11C General - All leakage tests shall be completed and approved following the placement and densification of the back fill, but prior to placing of permanent surfacing.

When leakage or infiltration exceeds the amount allowed by the specifications, the Contractor at its expense shall locate the leaks and make the necessary repairs or replacements in accordance with the specifications to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests. Leakage tests shall be made on completed pipelines as follows:

1. Gravity Sanitary Sewer (24 inches (610 mm) or less in diameter where difference in elevation between inverts of adjacent maintenance holes is 10 feet (3.05 M) or less) - Water exfiltration test or water infiltration test as directed. The Engineer may allow substitution of an air pressure test for the water exfiltration test.
2. Gravity Sanitary Sewers (24 inches (610 mm) or less in diameter where difference in elevation between inverts of adjacent maintenance holes is greater than 10 feet (3.05 M) - Air pressure test.
3. Gravity Sanitary Sewers (greater than 24" (610 mm) in diameter) - Air pressure test or water infiltration test as directed.
4. Pressure Sewers (force mains) - Water pressure test at 50 psi (345 kPa) over pipe pressure classification or designation.

71-1.11D Water Exfiltration Test - Each section of sewer shall be tested between successive maintenance holes by closing the lower end of the sewer to be tested and the inlet sewer of the upper maintenance hole with stoppers. The pipe and maintenance hole shall be filled with water to a point 4 feet (1.22 M) above the invert of the sewer at the center of the upper maintenance hole; or if ground water is present, 4 feet (1.22 M) above the average adjacent ground water level.

The allowable leakage will be computed by the formulae:

$E = 0.0001 LD \sqrt{H}$ for mortared joints.

$E = 0.00002 LD \sqrt{H}$ for all other joints.

where:

L is the length of sewer and house connections tested, in feet.

E is the allowable leakage in gallon per minute of sewer tested.

D is the internal diameter of the pipe in inches.

H is the difference in elevation between the water surface in the upper maintenance hole and the invert of the pipe at the lower maintenance hole; or if ground water is present above the invert of the pipe in the lower maintenance hole, the difference in elevation between the water surface in the upper maintenance hole and the ground water at the lower maintenance hole.

However, the maximum shall not exceed 200 gallons per inch of internal diameter per mile per day.

The Contractor shall, at its expense, furnish all water, materials and labor for making the required test. All tests shall be made in the presence of the Engineer.

71-1.11E Water Infiltration Test - If, in the opinion of the Engineer, ground water is encountered in the construction of a section of the sewer, the Engineer may require the pipe be tested by the Water Infiltration Test as follows:

The end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of ground water shall be discontinued for at least 3 days, or until the ground water has recovered its normal status level, after which the section shall be tested for infiltration.

The infiltration into each individual reach of sewer between adjoining maintenance holes shall not exceed that allowed by the formula in Section 71-1.11D where H is the difference in the elevation between the ground water surface and the invert of the sewer at the downstream maintenance hole.

Unless otherwise specified, infiltration will be measured by the Engineer using measuring devices furnished by the City.

All visible leaks shall be repaired by the Contractor regardless of volume involved.

71-1.11F Air Pressure Test - The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the City prior to the beginning of the test.

Each section of sewer shall be tested between successive maintenance holes by plugging and bracing all openings in the main sewer line and the upper ends of all sewer connections. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

The final leakage test of the sewer main line and branching sewer connections, shall be conducted in the presence of the Engineer in the following manner:

1. Clean pipe to be tested by propelling snug fitting inflated rubber ball through the pipe with water.
2. Plug all pipe outlets with suitable test plugs. Brace each plug securely.
3. If the pipe to be tested is submerged in ground water, insert a pipe probe by boring or jetting, into the backfill material adjacent to the center of the pipe, and determine the pressure in the probe when air passes slowly through it. This is the back pressure due to ground water submergence over the end of the probe. All gauge pressures in the test should be increased by this amount.
4. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.
5. After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
6. When pressure decreases to 3.5 psig, start stop watch.
- 6a. The following applies to all pipes other than PVC and ABS (see 6b):

Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times are indicated by the following formula and table in seconds:

$$t = k \left(\frac{d}{g} \right)$$

where t = minimum required time in seconds
k = constant 0.022

d = nominal pipe diameter in inches
g = allowable air loss rate per unit
area, 0.003 cu. ft./min./sq. ft.
of internal/surface area

psig = pounds per square inch gage

**MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE TO DROP
FROM 3 ½ TO 2 ½ PSIG**

PIPE DIAMETER

		4"	6"	8"	10"	12"	15"	18"	21"	24"	27"	30"	33"	36"	39"
L E N G T H O F L I N E I N F E E T	25	4	10	18	28	40	62	89	121	158	200	248	299	356	418
	50	9	20	35	55	79	124	178	243	317	401	495	599	713	837
	75	13	30	53	83	119	186	267	364	475	601	743	898	1020	1105
	100	18	40	70	110	158	248	256	485	634	765	851	935		
	125	22	50	88	138	198	309	446	595	680					
	150	26	59	106	165	238	371	510							
	175	31	69	123	193	277	425								
	200	35	79	141	220	317									
	225	40	89	158	248	340									
	250	44	99	176	275										
	275	48	109	194	283										
	300	53	119	211											
	350	62	139	227											
	400	70	158												
	450	79	170												
	500	88													
	550	97													
	600	106													
	650	113	170	227	283	340	425	510	595	680	765	851	935	1020	1105

NOTES: (1) TO BE USED WHEN TESTING ONE DIAMETER ONLY

(2) The above air pressure test procedure is based on ASTM C828. Any special situations or conditions shall conform to this ASTM Standard.

- 6b. For PVC and ABS lines the following table lists the minimum times allowed for a pressure drop from 3.5 psi to 3.0 psi in excess of the ground water pressure at the top of the pipe.

Pipe Dia (in)	Min Time (min sec)	Lgth for Min Time (ft)	Time for Lngr Lgth (sec)	Specification Time for Length (L) shown (min:sec)							
4	1:53		.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50		.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47		.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43		1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40		1.709L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05		2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02

SAFETY NOTE:

The air test may be dangerous if, because of ignorance or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. Inasmuch as a force of 250 lbs. is exerted on an 8" plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous.

As a safety precaution, pressurizing equipment should include a regulator set at perhaps 10 psi to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the maintenance holes during testing.

IF THE TIME LAPSE IS LESS THAN THAT SHOWN IN THE TABLE, THE CONTRACTOR SHALL MAKE THE NECESSARY CORRECTIONS TO REDUCE THE LEAKAGE TO ACCEPTABLE LIMITS.

71-1.11G Televising of Sanitary Sewers - Following the placement and compaction of backfill and completion of other required testing, but prior to the placing of pavement, the Contractor shall televise all sewer lines for conformance to the Project Plans and specifications. A tape and log of the televising shall be delivered to the Engineer within a week of televising. If defective pipes or conditions are discovered they shall be corrected at no cost to the City. Any corrective work proposed shall be approved by the Engineer.

The City may also televise sewer lines prior to the expiration of the one year warranty. If a defective condition is found, it shall be presumed to be caused by defective workmanship or materials. The developer and/or Contractor shall be notified and shall correct the work in a manner approved by the Engineer.

71-1.12 Measurement - Sewer work performed under Section 71, "Sewers," will be designated in the contract item by size, type, thickness, quality, or whatever information is necessary for identification.

The lengths of the various types of sewer pipe to be paid for by the linear foot; measured from centerline of maintenance hole to center line of maintenance hole between structures or to end of line not terminated at a structure.

Pipe bends, wyes, tees and other branches will be measured by the linear foot for the sizes of pipes involved. Bends will be measured along centerlines. Wyes, tees, and other branches will be measured along centerlines to the point of intersections.

Quantities of precast concrete pipe sewer maintenance holes, lampholes, terminal cleanout structures, and pipe chimneys will be determined as units from actual count, except new frames and covers.

New frames and covers will be considered as a part of the structure to which the frame and cover is attached and no additional compensation will be allowed therefor.

The quantities of permanent trench resurfacing to be paid for shall be the actual quantities placed within limits up to a maximum width of 3 feet greater than the outside diameter of the pipe or structure. Temporary trench resurfacing shall be paid for by the Contractor.

Trench quantities in excess of the above shall be at the Contractor's expense unless approved otherwise by the Engineer.

71-1.13 Payment - Items of work, measured as provided in Section 71-1.12, "Measurement," will be paid for at the contract price per linear foot for the various sizes of pipes, types of sewer maintenance holes, lampholes, terminal cleanout structures, and the contract price per ton or square foot for the various types of surfacing.

Full compensation for structure excavation; structure backfill; bar reinforcing steel and concrete will be considered as included in the contract price paid for the various items of sewer work and no separate payment will be made therefor.

Shaping the bottoms of new maintenance holes will be considered as a part of the maintenance hole and no separate payment will be made therefor.

Full compensation for all tunneling and jacking of pipe, capping open ends of pipe, joining of pipe to other pipe or structure, shaping bottoms of existing maintenance holes, utility support and protective work operations required to accommodate or safeguard public traffic, testing the sewer line, furnishing and disposing of water and equipment used for testing and all other incidental work and material required to construct the sewer system shall be

considered as included in the prices paid for the various contract items of sewer work and no additional compensation will be allowed therefor.

The above prices and payments shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing sewers, complete in place, as shown on the Project Plans, and as specified in these specifications and the special provisions, and as directed by the Engineer.

71-1.14 Abandonment - Sanitary sewer lateral abandonment shall be done at the property line. Provide bell end or collar with air tight plug, as specified in the U.P.C., at the end of the line.